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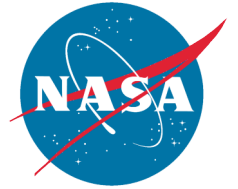
**Breakout Session Summary:**

***Spacecraft Charging and Discharging***

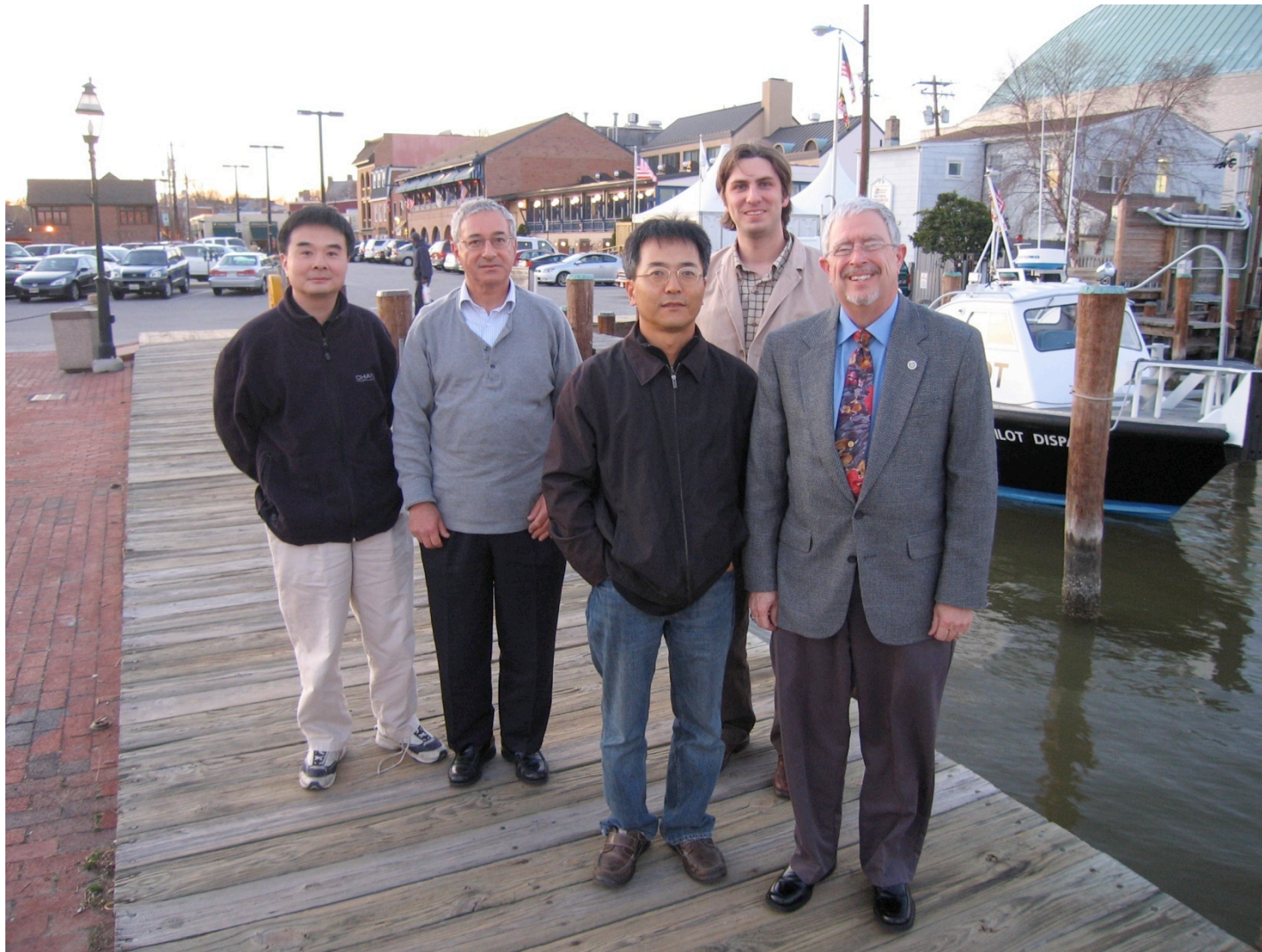
**Co-Chairs: Dale Ferguson (NASA/MSFC)  
Myron Mandell (SAIC)**

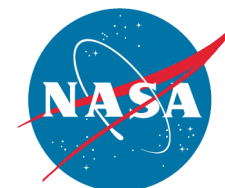
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**SET-3 Requirements Workshop  
March 29-30, 2007**



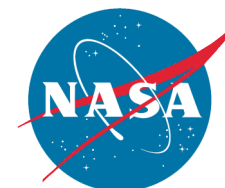
## ***Charging Breakout Team***





## *Waiting for Dinner*

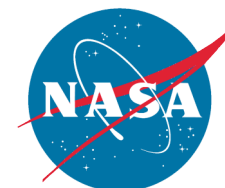




## ***Background***

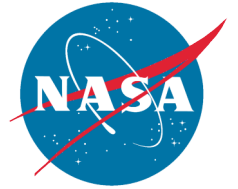
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- **Reviewed LWS-SET Goals and Objectives.**
- **Reviewed issues raised by session participants.**
- **Brainstormed for other issues.**
- **Issues were categorized, but not prioritized.**
- **After consultation with LWS authorities, agreed that ground test data as well as space data could be mined.**
- **Discussed whether data needed to be public or publicly released.**
  - **Decided that data not included in final product was not required to be public.**



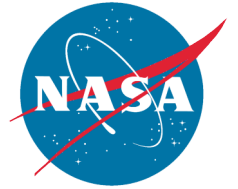
## ***Categorized List***

- **Data Mining of Existing Ground Test Data To Support Spacecraft Charging Issues**
  - Compilation of Charging/Discharging Properties of Materials
  - Geometry and Material Dependences of LEO Arcing Thresholds
- **Spacecraft Charging Environment Characterization**
  - Auroral Environment for Charging
  - Ram/Wake and Transient Effects in LEO
  - Transient charging associated with spacecraft passage through high density gradient regions.
  - GEO Charge Plate Analyzer/Charging Hazard Warning Indicator
- **Spacecraft Induced Environments**
  - GEO Charge Plate Analyzer /EP Plume Correlative Environment
  - Neutralizing Plasma Sources in GEO
  - Spacecraft Plasma Interactions related to Normal and Abnormal EP Plume Emissions
- **Deep Dielectric Charging**
  - Bulk Charging Tool
  - CRRES IDM Data Mining
- **Lunar Charging Issues**
  - Differential Charging on Lunar Surface



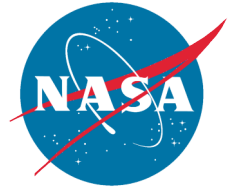
# ***Data Mining of Existing Ground Test Data To Support Spacecraft Charging Issues***

- **Compilation of Charging/Discharging Properties of Materials**
- **Geometry and Material Dependences of LEO Arcing Thresholds**



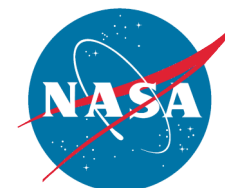
# ***Spacecraft Charging Environment Characterization***

- **Auroral Environment for Charging**
- **Ram/Wake and Transient Effects in LEO**
- **Transient charging associated with spacecraft passage through high density gradient regions.**
- **GEO Charge Plate Analyzer/Charging Hazard Warning Indicator**



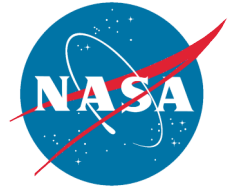
## ***Spacecraft Induced Environments***

- **GEO Charge Plate Analyzer /EP Plume Correlative Environment**
- **Neutralizing Plasma Sources in GEO**
- **Spacecraft Plasma Interactions related to Normal and Abnormal EP Plume Emissions**



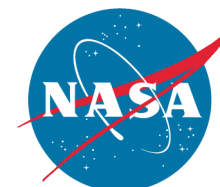
## ***Deep Dielectric Charging***

- **Bulk Charging Tool**
- **CRRES IDM Data Mining**



## ***Lunar Charging Issues***

- **Differential Charging on Lunar Surface**



Technology Breakout Session (Check One):

- Environment Specification
- Microelectronics
- Sensors & Detectors
- Materials
- x— Charging/Discharging

Title of Issue Requiring Investigation:

### **Compilation of Charging/Discharging Properties of Spacecraft Materials**

Background: **Accurate knowledge of the electron emission and charge transport properties of a wide variety of conducting and insulating materials is required to effectively model and mitigate spacecraft charging effects in all charging environments. Existing databases provide essential input to modeling codes such as NASCAP 2k.**

Description of Needed Investigation: **Mine electron emission, resistivity and radiation induced conductivity data acquired at NASA sponsored facilities in recent years to extend an existing NASA Charge Collector Knowledgebase to include a much broader set of spacecraft materials. New data includes affects of the variable solar environment through changes in temperature, accumulated charge, electric field, surface contamination, radiation induced conductivity and radiation damage.**

Justification: **Extensive electron emission, resistivity and radiation induced conductivity data have been acquired over the last several years at NASA sponsored facilities at JPL and USU. To be used by a wider community in charge modeling tools, these data need to be incorporated into existing NASA Charge Collector Knowledgebase.**

Benefiting Technology Areas:

**Spacecraft subsystems, Satellite instrumentation and sensors, Materials properties, Electronics interrupts**

Benefiting Space Application Areas:

**Mitigation and modeling of spacecraft, satellites, and sensors in all space environments**

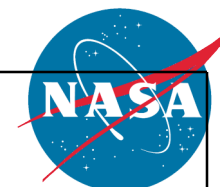
Investigation Resource Requirements:

Data Access Requirements (data name, cost): JWST, SPM, RBSP, Solar Sail, USU, JPL, ISGC. No cost

Submitter Information:

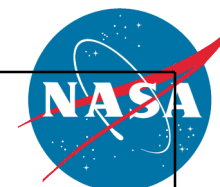
Name: JR Dennison

Nelson Green

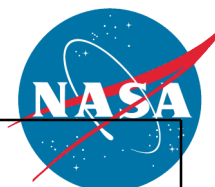


<p>Technology Breakout Session (Check One):</p> <ul style="list-style-type: none"><li>— Environment Specification</li><li>— Microelectronics</li><li>— Sensors &amp; Detectors</li><li>— Materials</li><li>x—x Charging/Discharging</li></ul>	<p>Title of Issue Requiring Investigation:</p> <p>Geometry And Material Dependences Of LEO Arcing Thresholds</p>
<p>Background: At sufficiently high negative voltages, solar arrays will arc into the LEO plasma. Many arc mitigation techniques rely on using specific materials or geometries to increase the arcing threshold above the highest expected charging level. For example, the new NASA-STD-4005 LEO Spacecraft Charging Design Standard lists 14 methods to mitigate LEO solar array arcing. Yet, no quantitative guidance is offered. This is because no systematic compilation of the efficacy of changing geometries or materials on increasing arc thresholds has been done. However, many quantitative ground-tests have been done of arc thresholds in a simulated LEO environment.</p>	
<p>Description of Needed Investigation: Compile and analyze the data sets of plasma conditions and LEO arc thresholds so that quantitative comparisons of the thresholds can be made for various spacecraft charging mitigation techniques. Datasets to be compiled will be the extensive NASA GRC and MSFC arc testing results and to the extent possible the ESA/CNES/ONERA and JAXA datasets. Analysis will show trends due to changes in coverglass overhang, coverglass thickness, gap between coverglasses, grouting and adhesives, substrate materials, etc., on the trigger arc and sustained arc thresholds.</p>	
<p>Justification: Mitigation of spacecraft charging in LEO depends on our understanding of the way in which spacecraft solar array materials and geometries modify their arc thresholds. The datasets proposed for analysis span the gamut of space solar array designs. All of the datasets include plasma conditions and arc thresholds and have not been sufficiently analyzed.</p>	
<p>Benefiting Technology Areas:</p> <p>LEO spacecraft solar array design and operations</p>	<p>Benefiting Space Application Areas:</p> <p>LEO charging, Large spacecraft, High voltages, Solar arrays, Arc mitigation.</p>
<p>Investigation Resource Requirements: 1/2 FTE/yr</p> <p>Data Access Requirements (data name, cost): GRC, MSFC, ESA, CNES/ONERA, JAXA</p>	<p>Submitter Information:</p> <p>Name: Dale Ferguson</p>

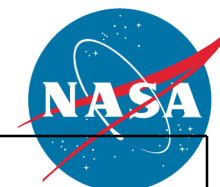
<b>Technology Breakout Session (Check One):</b>  <input type="checkbox"/> Environment Specification <input type="checkbox"/> Microelectronics <input type="checkbox"/> Materials <input type="checkbox"/> Sensors & Detectors <input checked="" type="checkbox"/> Charging/Discharging	<b>Title of Issue Requiring Investigation:</b>  <div data-bbox="1759 126 1984 310" data-label="Image"> </div> Develop Auroral Environment Model for Use in Surface Charging Calculations.
<b>Background:</b> Anomalies due to spacecraft surface charging have been observed on spacecraft during auroral passage. Charging calculations currently use the Fontheim description of the plasma environment, which has a large number of parameters and is difficult to understand. Only a few instances of this description are available, and there is no good statistical characterization. For design and simulation purposes we need a simpler and statistically well characterized environment, with one or two instances recommended as standards.	
<b>Description of Needed Investigation:</b> Use DMSP data and corresponding <i>Nascap-2k</i> calculations to identify energy range, functional form, and fitting procedure to determine auroral environment description appropriate for accurate charging calculations. Determine appropriate worst case environments for 90° and 57° inclination orbits.	
<b>Justification:</b> While charging during auroral passage is well-established, the plasma environment that causes charging is currently given in a complex treatment, for which only a few examples exist. For design purposes we need a formulation that has fewer parameters and is better characterized statistically. This would aid the design of numerous high-inclination LEO spacecraft, as well as identifying possible auroral charging of the shuttle and ISS.	
<b>Benefiting Technology Areas:</b> Plasma Effects Electrostatic Cleanliness	<b>Benefiting Space Application Areas:</b> Instruments and operations on high inclination LEO satellites. ISS and shuttle charging concerns.
<b>Investigation Resource Requirements:</b>  <b>Data Access Requirements (data name, cost):</b> DMSP environment and potential measurements; included in investigation cost.	<div data-bbox="1052 1105 1944 1495" data-label="Form"> <b>Submitter Information:</b>           Name: Victoria A. Davis / Myron J. Mandell       </div>



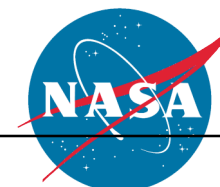
<p>Technology Breakout Session (Check One):</p> <ul style="list-style-type: none"><li>– Environment Specification</li><li>– Microelectronics                      – Materials</li><li>– Sensors &amp; Detectors                x–x Charging/Discharging</li></ul>	<p>Title of Issue Requiring Investigation:</p> <p>Characterizing Ram/Wake and Transient Spacecraft Effects in LEO</p>
<p>Background: Spacecraft modify their plasma environments by ram/wake effects, docking and undocking, neutral and ionized effluents, and electric and magnetic fields. As plasma environments change with the solar cycle and short-term solar activity, these spacecraft effects change, and yet the effects are extremely important in determining the spacecraft charging and arcing conditions. There are multiple data sets taken with different times in the solar cycle and at different ram/wake, electric field, and spacecraft sizes, that have not been properly analyzed to better characterize the spacecraft effects. Many of these data were obtained when our understanding of the LEO environment was not as well developed as at present, and we did not know what we were to be looking for.</p>	
<p>Description of Needed Investigation: Fully analyze the data sets of plasma conditions and spacecraft charging for the STS-3 PDP (1987, Shuttle), PIX-2 (1982, small polar spacecraft), PASP+ (1993, small tethered spacecraft), SAMPIE (1994, Shuttle), PMG (1994, small spacecraft), FPP (2001, ISS), and FPMU (2007, ISS) datasets with respect to ram/wake and transient effects, to better characterize the effect of large and small spacecraft on the plasma charging conditions around them.</p>	
<p>Justification: Mitigation of spacecraft charging in LEO depends on our understanding of the way in which spacecraft modify their surroundings in different orientations and phases in the solar cycle. The datasets proposed for analysis span the gamut of solar cycle, spacecraft size, orientation, and spacecraft charging. All of the datasets include plasma conditions and spacecraft charging (and some monitored arcing), and have not been sufficiently analyzed.</p>	
<p>Benefiting Technology Areas: LEO spacecraft design and operations</p>	<p>Benefiting Space Application Areas: LEO charging, Large spacecraft, High voltages, Solar arrays, Arc mitigation.</p>
<p>Investigation Resource Requirements: 1/2 FTE/yr</p> <p>Data Access Requirements (data name, cost): STS-3 PDP, PIX-2, PASP+, SAMPIE, PMG, FPP, and FPMU dataset access</p>	<p>Submitter Information:</p> <p>Name: Dale Ferguson</p>



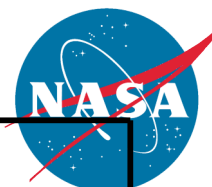
<p>Technology Breakout Session (Check One):</p> <p>—Environment Specification</p> <p>— Microelectronics                      — Materials</p> <p>— Sensors &amp; Detectors                X Charging/Discharging</p>	<p>Title of Issue Requiring Investigation:</p> <p>Transient charging associated with spacecraft passage through high density gradient regions.</p>
<p>Background:</p> <p>Charging from spacecraft produced exhaust plumes is well known. The natural environment produces sharp density gradients encountered by spacecraft in a recurring basis that are well characterized and that can be used as test inputs to examine the resulting charging environment.</p>	
<p>Description of Needed Investigation:</p> <p>Utilize data from satellites going through “plasma plume” regions where large plasma density gradient exists and plasma particle simulation codes to characterize transient plasma charging/discharge effects.</p>	
<p>Justification:</p> <p>The majority of research on spacecraft charging so far have been focused on the steady state. Few models and tools current exist to characterize plasma interactions effects for spacecraft going through high density gradient regions. Transient plasma charging and its effects on plasma instruments and plasma measurements are not well understood. It is thought that transient charging can lead to higher differential charging on spacecraft than predicted by steady state simulations.</p>	
<p>Benefiting Technology Areas:</p> <p>Spacecraft Charging; Effects of Spacecraft charging on plasma measurements</p>	<p>Benefiting Space Application Areas:</p> <p>Spacecraft Design; Instrument Design; Charging Effects Mitigation</p>
<p>Investigation Resource Requirements:</p> <p>Data Access Requirements (data name, cost): LANL Geo satellite data sets</p>	<p>Submitter Information:</p> <p>Name: Joseph Wang</p> <p>Name: Reiner Friedel</p>



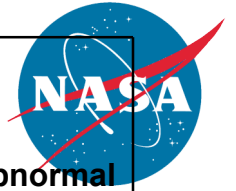
Technology Breakout Session (Check One): <input type="checkbox"/> Environment Specification <input type="checkbox"/> Microelectronics <input type="checkbox"/> Materials <input type="checkbox"/> Sensors & Detectors <input checked="" type="checkbox"/> Charging/Discharging	Title of Issue Requiring Investigation:  <b>Warning of Possible Charging Hazard for S/C Subsystems, Instruments, and Sensors:          Can Charge Plate Analyzer (CPA) Be Used?</b>
<p>Background: One way to mitigate against hazardous charging conditions is to take preventive measures when those conditions arise (turning off sensitive instruments, for example). This requires knowing the possible charging hazard exists. A spacecraft charging hazard—differential charging—requires high temperature and high current.</p> <p>One possible approach is to use Charge Plate Analyzers (CPA) which are relatively inexpensive and which may provide a good warning of charging hazard, despite being poor indicators of plasma temperature. CPAs respond primarily to plasma current and secondarily to plasma temperature. CPAs also have a distinctive response to nearby discharges on the spacecraft. A recent study by Koons et al. showed that, although CPA response to known charging events can be demonstrated, there was little correlation over a broad range of conditions (1) between CPA measurements and temperature measurements by nearby LANL MPAs and (2) between CPA readings on neighboring spacecraft. The lack of correlation between CPA reading on nearby spacecraft is surprising.</p>	
<p>Description of Needed Investigation: In order to use CPA measurements to predict that a possible charging hazard condition exists, it needs to be shown that the CPA response correlates with the conditions that create differential charging as measured by a nearby LANL MPA (perhaps augmented with low energy SOPA data) and/or correlates with discharges measured by the CPA. It would also be helpful to revisit the extent to which CPA readings on neighboring spacecraft can be correlated. Additionally, exploring correlations of CPA data and CPA measured discharges with solar wind parameters could further improve the charging hazard alarming algorithm. Both CPA data (on 4 spacecraft over 4 years) and corresponding LANL MPA data exists to support such an investigation.</p>	
<p>Justification: The ability to quickly respond to hazardous charging conditions could significantly improve the performance and life-expectancy of critical spacecraft subsystems, scientific instruments, and delicate sensors. This would positively support the aerospace community as well as help to address NASA's goal to better understand the effects of space weather on spacecraft.</p>	
Benefiting Technology Areas: Spacecraft Subsystems Science Instruments and Sensors	Benefiting Space Application Areas: Situational Awareness Charging Hazard Early Warning
Investigation Resource Requirements: Data Access Requirements (data name, cost): •Historical CPA data to be provided by spacecraft operators via LMCSS •LANL MPA and SOPA data (cost to accumulate and format)	Submitter Information:  Name: Myron J. Mandell



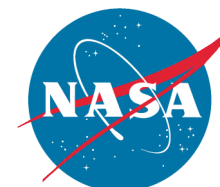
<b>Technology Breakout Session (Check One):</b> <input type="checkbox"/> Environment Specification <input type="checkbox"/> Microelectronics <input type="checkbox"/> Materials <input type="checkbox"/> Sensors & Detectors <input checked="" type="checkbox"/> Charging/Discharging <input type="checkbox"/> Correlative Environments	<b>Title of Issue Requiring Investigation:</b>  <b>Characterization of Combined GEO and Electric Propulsion Plume Plasma Environment and Design Guidelines for Minimizing Effects on Spacecraft, using Charge Plate Analyzer Data.</b>
<b>Background:</b> <p>The influence of surface charging, and associated ESD-induced spacecraft anomalies at GEO is well documented, and GEO charging guidelines, including those published by NASA (Ferguson and Hillard), are well understood by spacecraft designers and operators. However, in addition to the natural plasma environment at geosynchronous orbit, spacecraft are also exposed to propulsion plume effluents, some of which are partially ionized to the extent that, for some period of time, the spacecraft is exposed to plasma parameters (density and temperature) comparable to those experienced by LEO orbiting spacecraft. This combination GEO/EP-plume plasma environment needs to be characterized and the effects on spacecraft sub-systems better understood. One approach to doing this is to extend the plasma plume modeling capabilities of the SAIC-developed Nascap-2K/EPIC software suite and to validate the new model using data from Charge Plate Analyzer (CPA) sensors on-board the Lockheed-Martin-built Series-7000 GEO telecommunications spacecraft (which include arcjet electrothermal thrusters for NSSK).</p>	
<b>Description of Needed Investigation:</b> <p>Use existing, and enhanced features of the Nascap-2K/EPIC software suite, along with LM-supplied on-orbit Charge Plate Analyzer and arcjet NSSK data, to develop a high fidelity model of plume plasma flow around charged spacecraft surfaces. Models, and corresponding analysis, would be used to characterize how spacecraft charging and discharging is affected by the presence of arcjet plume plasma. Design practice recommendations for GEO-located spacecraft utilizing electric propulsion would be developed based on the results of this analysis.</p>	
<b>Justification:</b> <p>This would positively support the aerospace design and spacecraft operating community as well as help to address NASA's goal to better understand the effects of space weather on spacecraft.</p>	
<b>Benefiting Technology Areas:</b> <ul style="list-style-type: none"> <li>•Spacecraft Subsystems - enhanced predictions of hardware / system performance in the space environment</li> <li>•Spacecraft Subsystems – characterization of spacecraft operations on charging and discharging</li> </ul>	<b>Benefiting Space Application Areas:</b> Improved design and/or operations models and design guidelines Situational awareness Charging hazard early warning
<b>Investigation Resource Requirements:</b> Data Access Requirements (data name, cost): <ul style="list-style-type: none"> <li>•Historical CPA / NSSK data to be provided by spacecraft operators via LMCSS</li> </ul>	<b>Submitter Information:</b> Name: Justin J. Likar



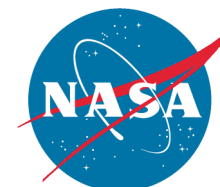
<b>Technology Breakout Session:</b> <input type="checkbox"/> <b>Environment Specification</b> <input type="checkbox"/> <b>Microelectronics</b> <input type="checkbox"/> <b>Materials</b> <input type="checkbox"/> <b>Sensors and Detectors</b> <input checked="" type="checkbox"/> <b>Charging/Discharging</b>	<b>Title of Issue Requiring Investigation:</b> Characterizing the efficacy of neutral plasma sources in the neutralization of differentially charged surface materials
<b>Background:</b> Dielectric materials commonly used on spacecraft surfaces are known to charge to thousands of volts negatively (relative to the spacecraft frame) in stormtime GEO plasma environments. The Charge Control Experiment (CCE) aboard DSCS-III B7 (GEO, 57.5 d West Longitude) consisted of electron and ion spectrometers, two Surface Potential Monitors (SPMs) covered by dielectrics (Kapton and Astroquartz), and a neutral Xe plasma source that was autonomously triggered by a Kapton SPM level that exceeded a preset threshold. Over five years of high-quality data were taken and archived.	
<b>Description of Needed Investigation:</b> Though surveys of the DSCS CCE data have been completed in the past, no systematic examination of the efficacy of charge neutralization by the Xe plasma source has been completed. With the combined analysis of DSCS CCE data along with modeling results from NASCAP-2K, investigators can systematically study the effects of neutralization parameterized by 1) charging environment, 2) S/C geometry and material properties, and 3) neutral plasma source properties.	
<b>Justification:</b> For active charge neutralization sources that are incorporated into new spacecraft designs, source design guidelines are needed.	
<b>Benefiting Technology Areas:</b> Dielectric surface charging and neutralization, Plasma Source Design	<b>Benefiting Space Applications Areas:</b> Spacecraft Design Guidelines, Plasma Source Design Guidelines, Active charge neutralization operations guidelines
<b>Investigation Resource Requirements</b> <b>Data Access Requirements:</b> DSCS-III B7 CCE Data (in house at USAF Academy)	<b>Submitter Information:</b> <b>Name:</b> Linda Habash Krause



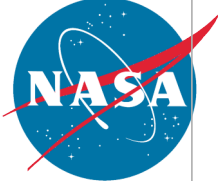
<p>Technology Breakout Session (Check One):</p> <p>— Environment Specification</p> <p>— Microelectronics</p> <p>— Sensors &amp; Detectors</p> <p>— Materials</p> <p><input checked="" type="checkbox"/> Charging/Discharging</p>	<p>Title of Issue Requiring Investigation:</p> <p><b>Plasma Interactions and Space Environment Modifications for Spacecraft with Normal and Abnormal EP Plume Emission</b></p>
<p>Background: Plasma emission devices have wide applications in both space science and space technology. Some examples include active perturbation plasma experiments (plasma beam sources), spacecraft charging control (plasma contactor), and electric propulsion (ion thrusters, hall thrusters).</p>	
<p>Description of Needed Investigation: Analyze IPS and PEPE data from both normal and abnormal operation of ion thruster during DS-1 mission to characterize 1) spacecraft-plasma interactions and induced charging from neutralized and un-neutralized plasma beams; 2) modification of spacecraft environments by beam emissions 3) transient charging and discharge; 4) charged beam neutralization in space.</p>	
<p>Justification: The physics and effects of spacecraft plasma interaction induced by charged beam emission are poorly understood. Currently no tools and models exist that can be used to adequately address interactions associated with beam emission. The IPS and PEPE data sets from the Deep Space 1 mission are probably the most comprehensive in-flight data that is current available for such interactions. They cover a wide range of conditions for thruster turn-on turn-offs and ion thruster operations in both normal and abnormal conditions. In particular, phenomena observed during the neutralizer plume mode operation near the end of DS1-mission indicate that complex set of plasma interactions were induced which may significant affect spacecraft charging, solar array performance, and the plasma environment surrounding spacecraft. However, the IPS and PEPE data from DS1 remain largely unanalyzed.</p>	
<p>Benefiting Technology Areas:</p> <p>Spacecraft Charging control; Electric Propulsion; Plasma effects.</p>	<p>Benefiting Space Application Areas:</p> <p>Charging/discharge control; beam neutralization in space; EP integration; EP system design; charging anomalies analysis.</p>
<p>Investigation Resource Requirements:</p> <p>Data Access Requirements (data name, cost): PEPE and IPS data from DS1 mission</p>	<p>Submitter Information:</p> <p>Name: Joseph J. Wang</p>



<b>Technology Breakout Session (Check One):</b> <input type="checkbox"/> Environment Specification <input type="checkbox"/> Microelectronics <input type="checkbox"/> Sensors & Detectors <input type="checkbox"/> Materials <input checked="" type="checkbox"/> Charging/Discharging	<b>Title of Issue Requiring Investigation:</b> NASA Bulk Charging Analysis Tool
<b>Background:</b> NASA standard bulk charging model required for use in designing space systems, planning operations in bulk charging environments, designing laboratory testing, and evaluating on-orbit anomalies.	
<b>Description of Needed Investigation:</b> Improve NUMIT charging code originally developed by R. Fredrickson into a NASA standard bulk charging code for use by NASA, US aerospace community.	
<b>Justification:</b> NUMIT has been shown to provide reasonable results but additional work is required on radiation transport algorithms, electric field dependent conductivity modeling, electric potential models, and other features of the code.	
<b>Benefiting Technology Areas:</b>	<b>Benefiting Space Application Areas:</b>
<b>Investigation Resource Requirements:</b> Data Access Requirements (data name, cost): Validation data (lab, space)	<b>Submitter Information:</b> Name: Joseph Minow



<b>Technology Breakout Session (Check One):</b>  <input type="checkbox"/> Environment Specification <input type="checkbox"/> Microelectronics <input type="checkbox"/> Materials <input type="checkbox"/> Sensors & Detectors <input checked="" type="checkbox"/> Charging/Discharging	<b>Title of Issue Requiring Investigation:</b>  CRRES IDM Data Mining
<b>Background:</b> Validation of bulk charging models can be accomplished using coincident discharge data with measurements of incident relativistic electron flux.	
<b>Description of Needed Investigation:</b> CRRES IDM discharge rates with coincident measurements of electron flux provide an outstanding opportunity to test bulk charging models.	
<b>Justification:</b> Previous SET funded work modeling discharge rates from IDM data sets only considered one of the PR4 samples, the rest of the samples need to be evaluated. Data set provides a rich opportunity to test charging models including development of discharge models.	
<b>Benefiting Technology Areas:</b>	<b>Benefiting Space Application Areas:</b>
<b>Investigation Resource Requirements:</b>  Data Access Requirements (data name, cost): CRRES, IDM no cost	<b>Submitter Information:</b>  Name: Joseph Minow

<b>Technology Breakout Session (Check One):</b>  <input type="checkbox"/> Environment Specification <input type="checkbox"/> Microelectronics <input type="checkbox"/> Materials <input type="checkbox"/> Sensors & Detectors <input checked="" type="checkbox"/> Charging/Discharging	<b>Title of Issue Requiring Investigation:</b>  Differential charging on the lunar surface 
<b>Background:</b> Lunar Prospector data reveals strong charging of the lunar surface when the moon passed through Earth's magnetotail. There is concern that such structures as dust, astronauts, and cables may differentially charge, or that such charging may cause more than expected dispersal of lunar dust.	
<b>Description of Needed Investigation:</b> Data mining from existing or former lunar studies to search for surface charging related information.	
<b>Justification:</b> Differential charging of lunar structures may lead to increased contamination or ESD.	
<b>Benefiting Technology Areas:</b> Lunar Surface Ops	<b>Benefiting Space Application Areas:</b> Constellation Program
<b>Investigation Resource Requirements:</b>  Data Access Requirements (data name, cost):	<b>Submitter Information:</b>  Name: Charging Breakout Team